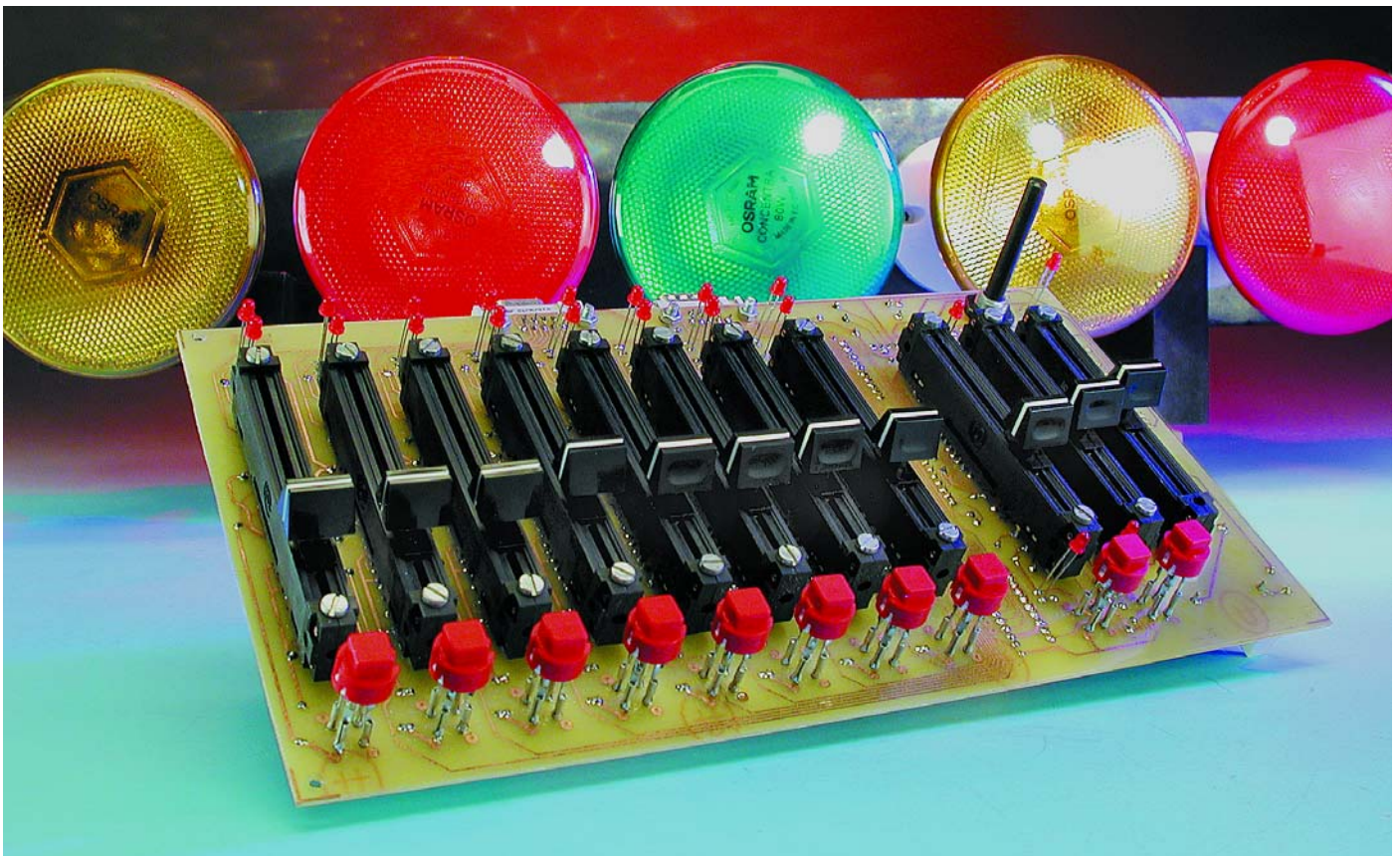


Light Mixer Panel

with eight channels

Design by J. Mack

This highly affordable eight-channel light mixer panel has all of the standard control features plus extras such as a switchable rhythm generator for the control inputs and optical output voltage indicators. Furthermore, the circuit is designed to accommodate extensions, in particular external control signals originating from a PC.



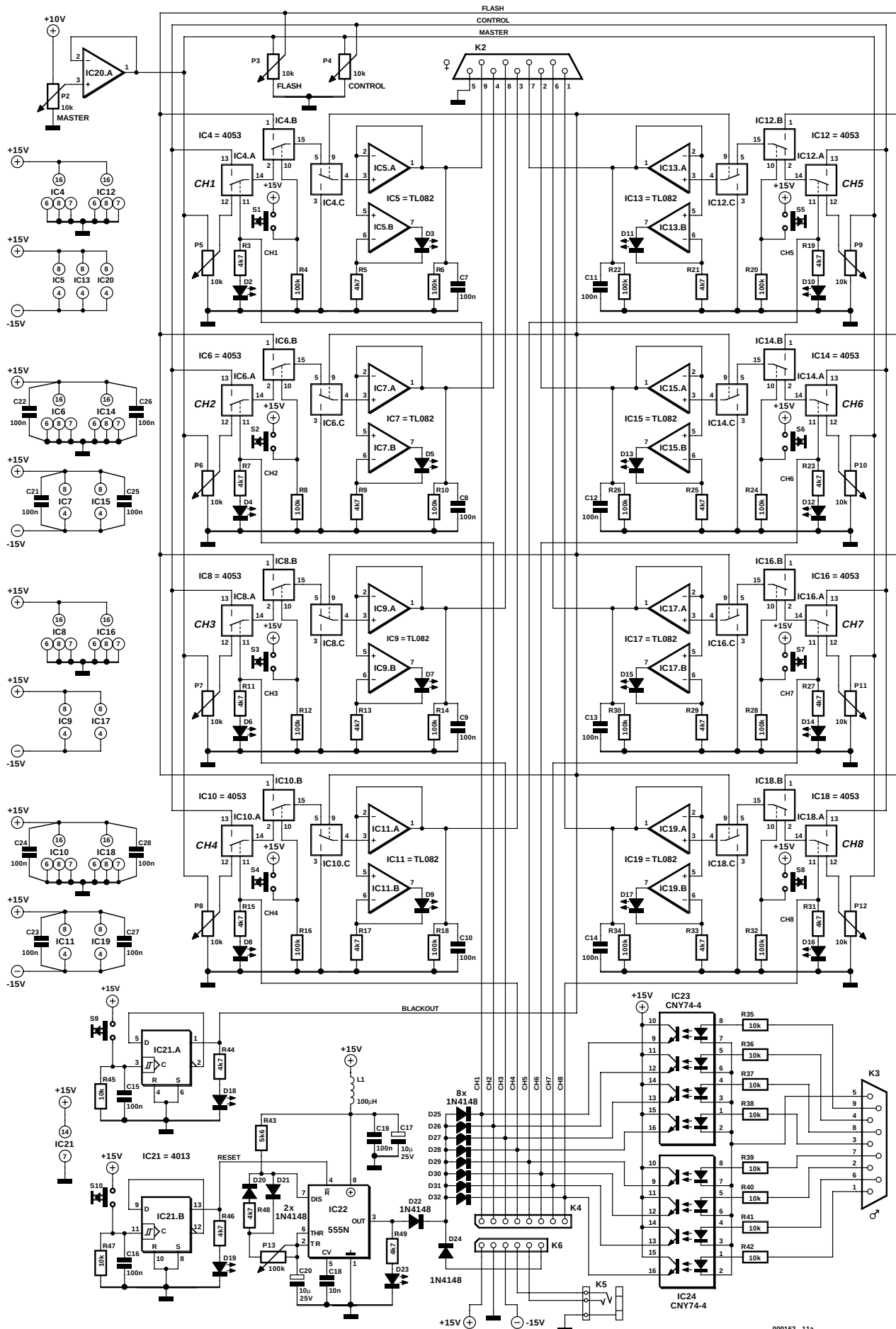
A light mixer panel forms the heart of every lighting installation in a theatre, concert hall or discotheque. The days when lighting control was limited to the legendary 'lights out, spot on' are far behind us. For some time

already, lighting has been regarded as an integral part of the performance. A light mixer panel is just as important for the lighting as an audio mixer panel is for sound. The job of the light mixer panel is to pro-

vide the control signals for the various dimmer/lamp combinations; it acts as a sort of 'user interface' between the responsible technician and the lighting installation.

There are many different models and types of light mixer panels, ranging from extremely

1a



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small boxes to large digital fader panels that occupy a whole desktop. A basic model for small to medium-sized halls usually consists of four to six channels, each having a (slide) potentiometer, while the common extra features are generally limited to a master fader that governs the total brightness and a 'flash button' for each channel. The latter feature allows the light to be briefly switched on 'full blast', independent of the potentiometer setting.

Features

In the design of this (analogue) light mixer panel, the author has gone somewhat further than just a basic model.

To start with, a choice has been made for eight channels, since that makes the unit quite a bit more versatile than a model with only four or six control outputs. Each channel has its own slide potentiometer, which adjusts the dc voltage on the associated output over the standard range of 0–10 V. This is the input voltage used by voltage-controlled dimmers. Naturally, there is also a master fader to allow all of the channels to be adjusted at the same time.

Flash buttons have also been considered to be a necessary feature, but in order to avoid being bound to 100% brightness, the flash level has also been made adjustable by means of a slide potentiometer. In addition, there is a 'blackout' button. This is more or less the opposite of the flash function, since as the name suggests, all outputs are switched to 0 V when this button is pressed.

Finally, there is also a control input for each channel, which allows a music controller to be connected to the mixer panel. A set of optocouplers and a sub-D connector have also been added to allow a PC to be used as the source of the (control) signals if desired. The level of the 'control' signal can be adjusted using a separate slide potentiometer.

In order to allow something useful to be done with the control function even in the absence of a music signal, a simple rhythm generator has been added to the circuit. This can be enabled at the press of a button, and its rate can be adjusted using a (rotary) potentiometer. The lights connected to the mixer will then flash in sync with the rhythm generator.

What else is there? One important feature is the provision of clear function indicators for the mixer panel. Each channel has its own LED level indicator, with the brightness of the LED corresponding to the level set for the output voltage — not an essential feature, perhaps, but certainly a handy way to monitor what you're doing when working in the dark or with subdued lighting. An additional set of eight LEDs indicate what's happening on the control inputs, while a further pair of LEDs indicate whether the blackout function and the rhythm generator are active.

Circuit description

The schematic diagram shown in **Figure 1** may appear to be horribly complicated at first glance, but it is

actually a lot simpler than it looks, since it is made up of eight identical blocks forming the individual channel faders.

First we'll describe the schematic diagram in general terms from top to bottom, in order to get an idea of where the various parts of the circuit are located. After that we will turn our attention to the details.

At the top left we find the master fader (P2). It is actually located between the power supply and the control portion and allows a voltage in the range of 0–10 V to be set. Moving to the right, we come to the slide potentiometers for the 'flash' and 'control' levels (P3 & P4), with the output connector (K2) located next to them. Signals for all of the controlled channels are present at this connector.

If we shift our glance downwards, we encounter the eight channel faders, which together take up around two thirds of the schematic diagram. To the left of them we see the power supply connections for the ICs, together with the necessary decoupling capacitors.

Below the faders, on the left-hand side, we find the flip-flop for the blackout function (IC21a). This is switched on and off by pressing S9. LED D18 indicates the status of this function. Directly below this we see an identical flip-flop (IC21b), which allows the rhythm generator built around IC22 to be enabled by pressing S10. Here D19 provides the status indication. The frequency of the rhythm generator can be set using P13 and checked using LED 23.

The portion of the schematic diagram at the bottom middle and right brings us to the 'extras' department. With an eye to possible extensions, all control inputs have been made directly accessible via connector K4. Connector K6 has also been added to allow for extension with music control, for example. The ± 15 -V supply voltage is present on this connector, and a signal can be inserted (or tapped off) via audio jack K5. The 9-way sub-D connector (K9) is intended to be used for connection to the parallel port of a PC, among other things. It can be used for connecting external control signals, which are electrically isolated from the rest of the circuit by optocouplers (IC23 & IC24).

Operation

Now that we have an idea of how the schematic diagram is organised, it's time to take a detailed look at the operation of the circuit. Our attention here will primarily be focused on the channel faders, since the rest of the circuit has already been fairly well described.

Let's start again with the master poten-

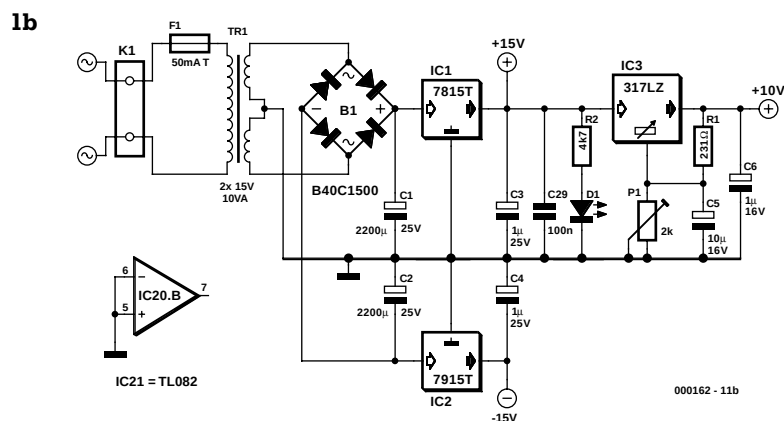
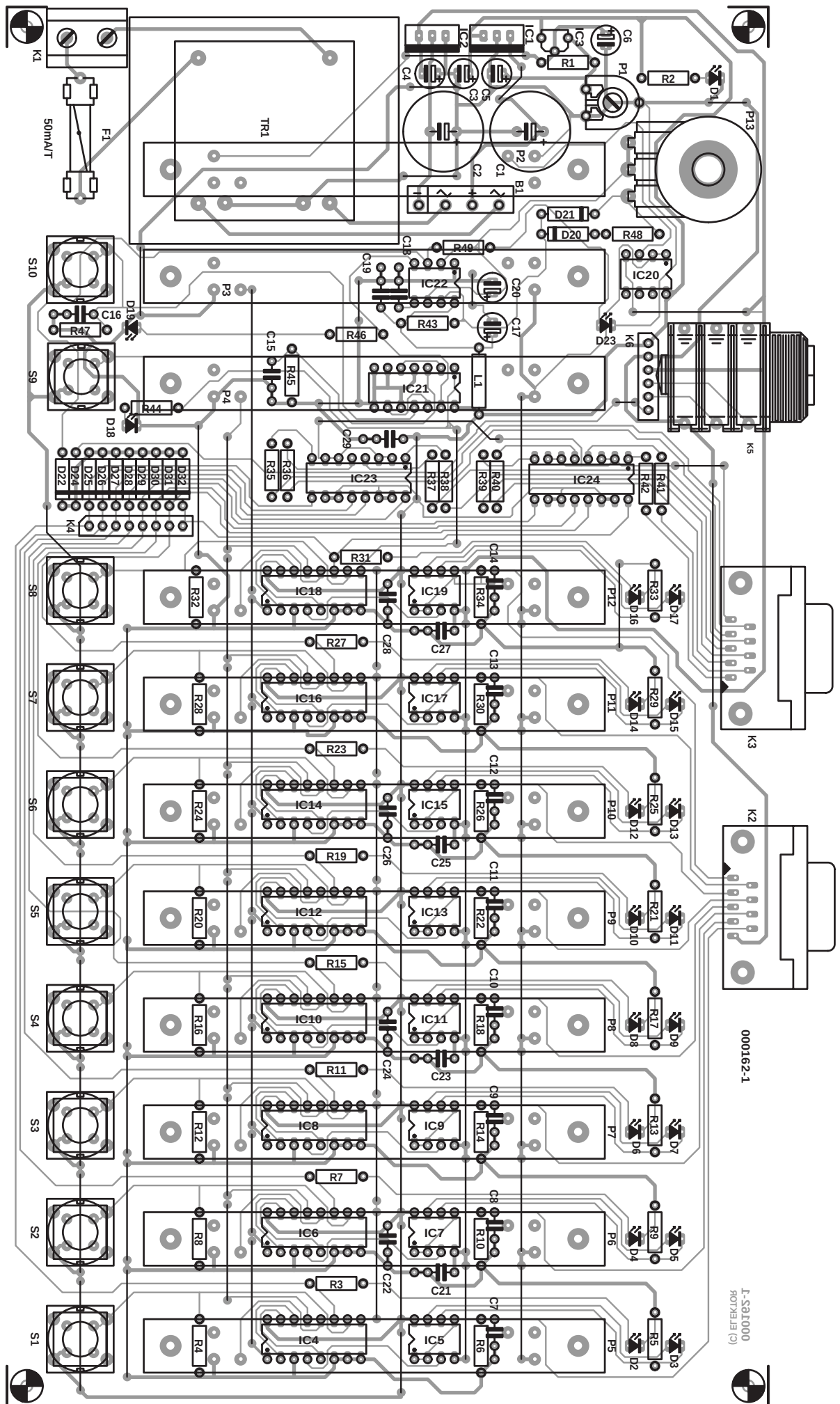


Figure 1. Although the schematic diagram is fairly extensive, it's actually not complicated. The power supply (1b) employs three integrated voltage regulators.



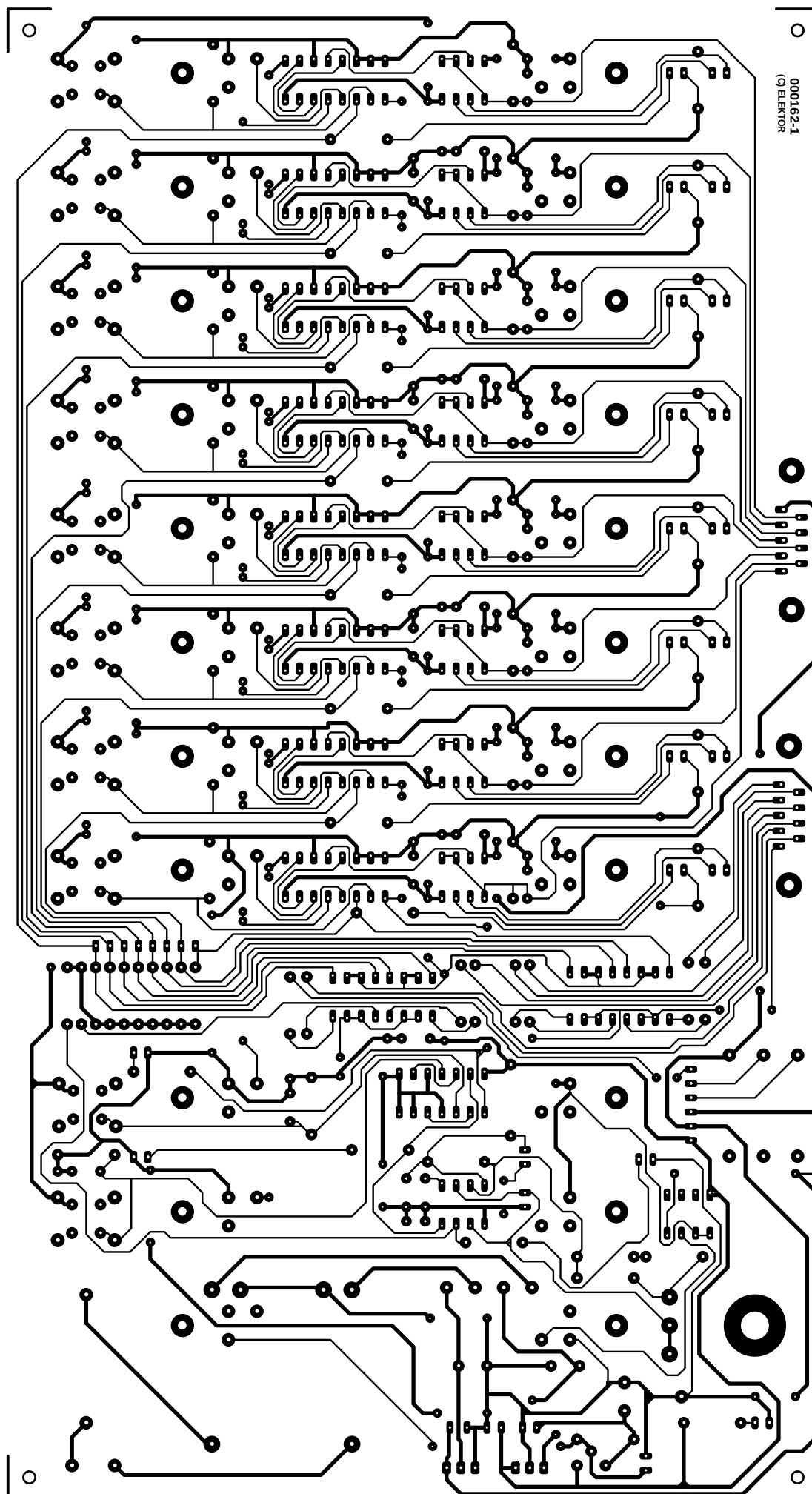


Figure 2. The printed circuit board (available from Readers Services) houses the complete circuit, including the various connectors and the power supply.

COMPONENTS LIST

Resistors:

R1 = 231Ω
 R2, R3, R5, R7, R9, R11, R13, R15, R17, R19, R21, R23, R25, R27, R29, R31, R33, R44, R46, R48, R49 = 4kΩ
 R4, R6, R8, R10, R12, R14, R16, R18, R20, R22, R24, R26, R28, R30, R32, R34 = 100kΩ
 R43 = 5kΩ
 R35-R42, R45, R47 = 10kΩ
 P1 = 2kΩ5 preset
 P2..P11 = 10kΩ slide potentiometer, linear law, e.g., Radiohm (Conrad Electronics # 44 14 49-60)
 P13 = 100kΩ potentiometer

Capacitors:

C1, C2 = 2200μF 25V radial
 C3, C4 = 1μF 25V radial
 C5, C17, C20 = 10μF 25V radial
 C6 = 1μF 16V radial
 C7-C16, C19, C21-C29 = 100nF
 C18 = 10nF

Inductors:

L1 = 100μH

Semiconductors:

B1 = B40C1500 bridge rectifier (40V piv, 1500mA continuous)
 D1-D18 = LED, red, 3mm, low current
 D2-D17, D19, D23 = LED, green, 3mm, low current
 D20, D21, D22, D24-D32 = 1N4148
 IC1 = 7815
 IC2 = 7915
 IC3 = LM317LZ
 IC5, IC7, IC9, IC11, IC13, IC15, IC17, IC19, IC20 = TL082
 IC4, IC6, IC8, IC10, IC12, IC14, IC16, IC18 = 4053
 IC21 = 4013
 IC22 = 555
 IC23, IC24 = CNY17-4

Miscellaneous:

S1-S10 = pushbutton, one make contact, e.g., D6-R (ITT Schadow)
 F1 = fuse 50mA (time lag) with PCB mount holder
 TR1 = mains transformer, PCB mount, 2x15V/10VA, e.g., ERA type EL48/16,8
 K1 = 2-way PCB terminal block, lead pitch 7.5 mm
 K2 = 9-way sub-D socket (female), PCB mount, angled pins
 K3 = 9-way sub-D socket (male), PCB mount, angled pins
 K4 = 8-way SIL pinheader
 K5 = stereo 6.35 mm jack socket, PCB mount
 K6 = 6-way SIL pinheader
 Enclosure: e.g. Teko 52 39 84-60 (310 x 170 mm)
 PCB, order code **000162-I** (see Readers Services pages)

tiometer P2. This is connected to a 10-V voltage provided by the power supply, so a voltage ranging from 0 V to 10 V is available on its wiper. In order to avoid undesired feedback, the wiper voltage is first buffered by IC20a, following which it serves as the input voltage for the 'flash' and 'control' adjustment potentiometers P3 and P4 (which act on all channels equally) and the individual channel potentiometers (P5-P12).

Since all eight-channel fader circuits are identical, we can limit our discussion to a description of the operation of the channel 1 fader, which consists of the circuitry around IC4 and IC5.

The desired level is set using P5. On its way to the output, the voltage from the wiper of the potentiometer passes through three electronic switches connected in series (IC4a, IC4b and IC4c). As long as no special function has been enabled, the signal simply passes through all three switches, following which the voltage is buffered by IC5a and fed to output connector K2. However, this situation changes if any of the three electronic switches is activated. Whenever a voltage is placed on the control input (either externally via K4 or by switching on the rhythm generator), switch IC4a is activated via the CH1 line. This breaks the connection to P5 and causes the 'control' signal to be passed through to the output, with the 'control' potentiometer P4 setting the output level. In this situation, LED D2 is illuminated.

If the 'flash' button (S1) is pressed, IC4b switches and the voltage level set by the 'flash' fader (P3) is passed through to the output.

The 'blackout' function acts on all channels simultaneously. Whenever this function is activated using pushbutton S9, IC4c switches. This breaks the through path and causes the input of buffer IC5a to be connected to ground. The output is thus always 0 V, regardless of any other settings.

An additional opamp (IC5b) has been added to indicate the output voltage. It acts as a voltage-to-current converter that changes the 0-10 V control voltage into a practically linear variation in the brightness of LED D3 (which, like all of the other

LEDs, must be a low-current type).

A low-pass filter in the form of C7 has been added to the output to eliminate possible cable effects. Resistor R6 acts as an open-circuit load.

Actually, we have now described the complete circuit. The only thing we still owe you is a few words of explanation regarding the rhythm generator, even though there's not really very much to say about it. As can be seen, it is built around a 555 timer (IC22) wired as a 'textbook' multivibrator, with the frequency being adjustable over the range of around 1-10 Hz using P13. Diodes D29 and D21 ensure that the duty cycle is 50%, and the combination of L1 and C17 prevents the +15-V line from being contaminated by noise pulses originating from the 555, since such pulses could have a detrimental effect on the analogue portion of the circuit. Via D22 (which prevents feedback), the signal output signal is applied to a diode network consisting of D25-D32, by means of which all control inputs can be driven simultaneously.

Power supply

The mixer panel needs three different power supply voltages: +15 V for the electronic switches, ±15 V (symmetrical) for the opamps and, last but not least, exactly +10 V for the input voltage to the faders.

As can be seen from the schematic diagram in **Figure 1b**, the power supply has been kept as simple as possible. The well-known combination of a transformer, a bridge rectifier module and a pair of electrolytic capacitors provides unregulated dc voltages of ±19-20 V. These are adequate input voltages for the 7815T and 7915T three-terminal regulators (IC1 and IC2), which deliver nicely stabilised voltages of +15 V and -15 V.

To generate a stable +10 V voltage, we have chosen an LM317LZ adjustable voltage regulator (IC3). In order to keep the dissipation of this regulator as low as possible, its input is taken from the +15-V line. The output voltage can be adjusted using P1. In order to compensate for possible losses, the voltage is best measured at the output connector

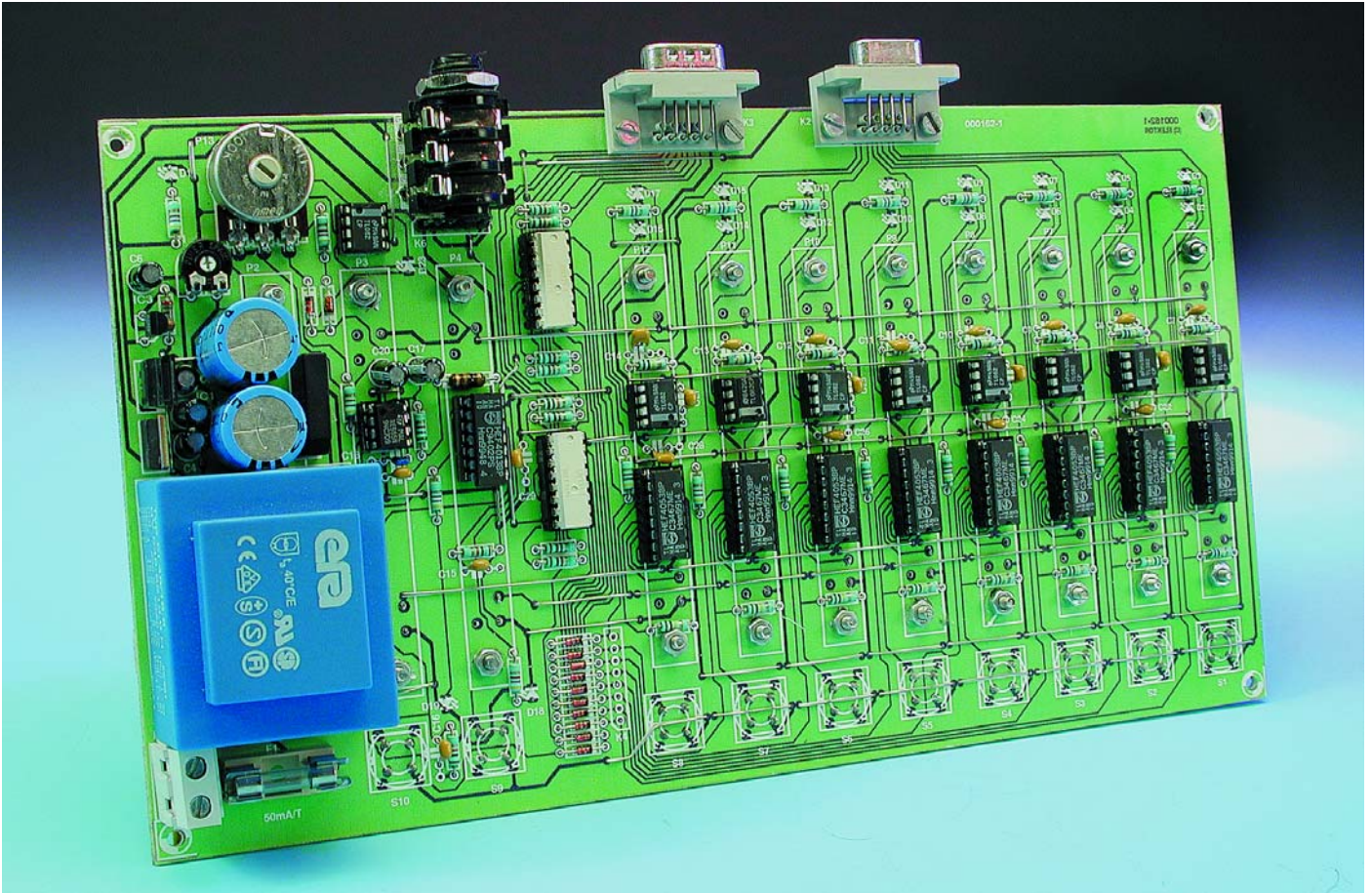


Figure 3. So, which is the top side and which is the bottom side? In any case, this is the component side.

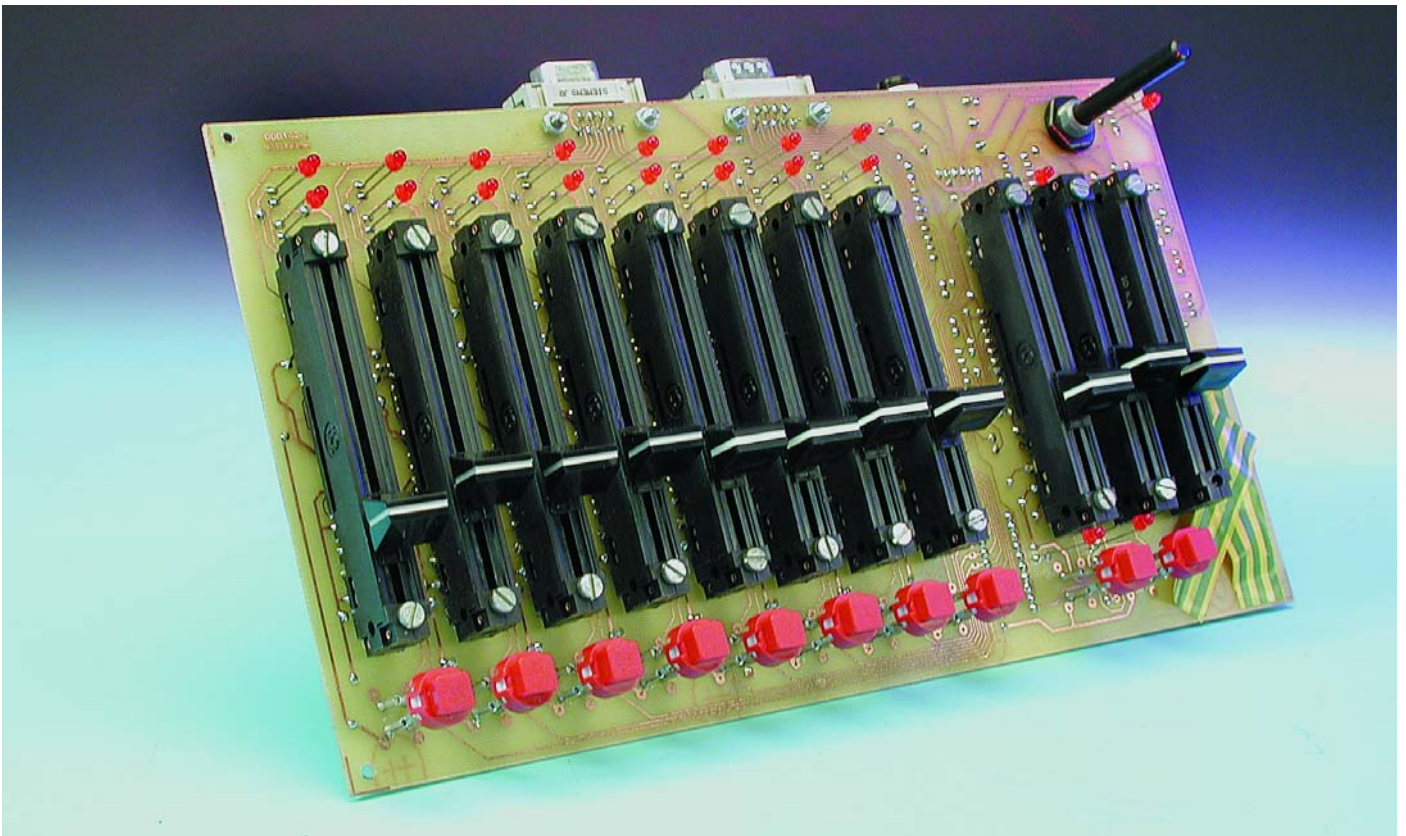


Figure 4. The switches, slide potentiometers and LEDs are fitted to the copper side.

(K2). For example, you can connect a voltmeter between pin 5 (ground) and pin 9 (channel 1 output), rotate P2 and P5 fully clockwise and then adjust P1 for a meter reading of exactly 10 V.

Now that's soldering!

The copper track and component layouts of the printed circuit board that has been designed for the mixer panel are shown in **Figure 2**. This circuit board houses the complete circuit, including the power supply, and since it has to provide space for eleven slide potentiometers, it is not exactly small.

Before saying anything about the construction of the circuit board, it's worth mentioning that a **single-sided** design has been used for the circuit board in order to reduce its cost. However, this means that quite a few wire bridges are required — no fewer than 79 in total! In combination with the fact that components must be fitted to both the 'normal' component side and the solder side of the board, this means that building this circuit board is not such a simple project. If you are not an experienced hobbyist, we thus recommend that you don't undertake this project unless you can be sure of help from an 'old hand'.

As noted, both sides of the circuit board must be 'assembled'. Everything is arranged such that all of the control elements, consisting of the slide potentiometers, the LEDs (including the on/off LED D1) and the pushbuttons, are fitted to the copper side and the remaining components are fitted to the regular component side.

You should start with the component side of the circuit board, and it is recommended to first fit all the wire bridges. Make a copy of Figure 2 and mark off each wire bridge as it is fitted, in order to avoid forgetting any of them. Pay careful attention, since a few of them are well hidden, such as those on either side of C2, the ones next to IC1 & IC2 and a very short one between K6 and P4. There are also two bridges that must be bent diagonally, next to IC21 and at S8.

After this, you can start to fit the other components, beginning as usual with the lowest components (resistors, diodes and IC sockets), followed by the higher components (electrolytic capacitors, voltage regulators, fuse holder and transformer).

The various connectors can also be fitted directly to the circuit board, with K2, K3 and K5 being intentionally located on the same side of the board, since this is much more practical when it comes time to fit the board into an enclosure.

Once all the components on the compo-

nent side have been fitted according to instructions, you can turn the board over and begin the difficult task of fitting the slide potentiometers one after another. Each potentiometer must be attached to the board with two M3 screws. Use distance rings (preferably plastic) to ensure that a clearance of a few millimetres is maintained between the bottom edge and the surface of the circuit board; otherwise you will not be able to reach the connection tabs with the soldering iron. For the same reason, you should preferably work from right to the left when fitting the slide potentiometers, which means first fitting P2, P3 and P4, followed by P12, P11 and so on.

In order to ensure that switches S1–S10 remain accessible after the board is mounted in an enclosure, they must be fitted a certain distance above the circuit board. With the prototype, this was achieved by soldering four pins to the circuit board for each switch and then soldering four pin sockets to the terminals of each switch. Naturally, other solutions are also possible.

The indicator LEDs must also be fitted with 'long legs' to ensure that they are visible after the board has been fitted into its enclosure. Fortunately, this is not particularly difficult, since LEDs come with long leads.

In the photos of the prototype circuit board shown in **Figures 3 & 4**, you can easily see the various construction details. It certainly won't do any harm to carefully compare your own board with the photos.

Since the light mixer panel does not include any alignment elements other than P1 in the power supply, strictly speaking there is no reason to expect it not to work right away. After the final component has been fitted to the board, there is thus a great temptation to immediately connect a mains cable to K1 and plug it in to an outlet. Still, there are two reasons why it is a good idea to exercise a bit of restraint. In the first place, due to the large number of wire bridges a very thorough visual inspection of the assembled board is in order. In the second place, you should firmly bear in mind that mains voltage is present on part of the circuit board, and it only needs a

moment of inattention to come in contact with this voltage. Be very careful what you do!

Fitting the enclosure

You are completely free in choosing a suitable enclosure, although naturally a console-type enclosure with a sloping top surface is the most suitable for this type of circuit.

For the prototype, we selected such an enclosure, namely the Teko model 52 39 84-60. With a width of 310 mm and a depth of 170 mm, this enclosure provides ample space for the circuit board, so you don't have to make the most of every millimetre. The circuit board can be attached to the inside of the sloping top face of the enclosure using a set of (plastic) standoffs. Suitable openings must be made for the potentiometer knobs, pushbuttons and LEDs. You should make a neat job of this, since an attractive result is naturally desirable.

Pay attention to the electrical safety of the overall construction. Provide a solid mains switch and mains entrance connector and a well-insulated connection between the mains entrance connector and connector K1. Furthermore, ensure that there is adequate clearance between the metallic parts of the enclosure and the fuse holder for F1 and the circuit board traces interconnecting K1, F1 and TR1! Finally, attach a copy of the type label accompanying this article to the rear of the enclosure, with a clear indication of the supply voltage and fuse value, in order to comply with safety regulations.

You can connect the various lights and other equipment to be controlled to connector K2. Some commercially available spotlights and other lighting equipment have built-in dimmers with 0–10 V control inputs. If you want to fit such dimmers to your own equipment, have a bit of patience — we will shortly be publishing a design for such a circuit in *Elektor Electronics*.

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